CLAIMS

1. An apparatus for stretching at least one polymer in a fluid sample, said apparatus comprising an elongation structure, wherein said elongation structure comprises a tapered channel, said tapered channel decreasing in width from a first end to a second end, and wherein said at least one polymer, when present, moves along said tapered channel from said first end to said second end and is stretched.

2. The apparatus according claim 1 wherein said tapered channel decreases linearly in width from a first end to a second end.

3. The apparatus according claim 1 wherein said tapered channel decreases in width at a greater than linear rate from a first end to a second end.

4. The apparatus according claim 2 wherein said tapered channel decreases in width at an angle between 1° and 75°, said angle being defined at said first end with respect to a constant-width channel.

5. The apparatus according to claim 4 wherein said angle is equal to 26.6°.

6. The apparatus according to claim 1 wherein said at least one polymer comprises DNA.

7. The apparatus according to claim 1 wherein said first end has a width between 1 μm and 1 cm, and said second end has a width between 1 nm and 1 mm.

8. The apparatus according to claim 1 further comprising a delivery region for delivering said at least one polymer in said fluid sample to said elongation structure.

9. The apparatus according to claim 8 wherein said delivery region comprises a delivery channel, said delivery channel leading into and out of said elongation structure.

10. The apparatus according to claim 1 wherein said elongation structure comprises a central channel for containing fluid and a plurality of side channels for containing fluid connected to said central channel.

11. The apparatus according to claim 10 wherein said plurality of side channels is oriented such that fluid injected from said plurality of side channels moves substantially in the flow direction along said central channel.

12. The apparatus according to claim 10 wherein said central channel has a central-channel cross-sectional area and said plurality of side channels has a total combined side-channel cross-sectional area between 1% and 500% of said central-channel cross-sectional area.

13. The apparatus according to claim 12 wherein said total combined side-channel cross-sectional area is about 50% of said central-channel cross-sectional area.

14. The apparatus according to claim 10 wherein said plurality of side channels are arranged in a pattern that is repeated.

15. The apparatus according to claim 1, wherein said channel has at least one bend.

16. The apparatus according to claim 15 wherein said channel has a sinusoidal shape.

17. The apparatus according to claim 16 wherein said sinusoidal shape has a ratio of amplitude to period between 0.01 and 5.

18. The apparatus according to claim 15 wherein said channel comprises a plurality of straight sections joined in tandem at nonzero angles.

19. The apparatus according to claim 18 wherein each of said plurality of straight sections has the same length and said nonzero angles are equal in magnitude and alternating in sign, whereby said channel has a zig-zag shape.

20. The apparatus according to claim 19 wherein each of said nonzero angles has a magnitude between 5° and 75°.

21. The apparatus according to claim 1 wherein said channel comprises a plurality of obstacles to motion of said at least one polymer.

22. The apparatus according to claim 21 wherein said plurality of obstacles comprises a plurality of posts, at least one of said posts having a non-quadrilateral polygonal cross sectional shape.

23. The apparatus according to claim 22 wherein at least one of said plurality of posts comprises a concave edge.

24. The apparatus according to claim 21 wherein said plurality of obstacles is positioned as a series of rows, each said row positioned perpendicular to flow direction, and each successive row offset from a previous row, whereby at least a portion not equal to a multiple of 1/2 of one of said obstacles overlaps an extension of a gap formed by two adjacent obstacles in said previous row along said flow direction.

25. The apparatus according to claim 21 wherein said plurality of obstacles is positioned as a series of rows, each said row positioned perpendicular to said flow direction, and each adjacent pair of obstacles in each of said series of rows is separated by a distance greater than 50 times minimum diameter of said at least one polymer when in stretched configuration.

26. The apparatus according to claim 1 wherein said tapered channel is a first tapered channel, said first tapered channel comprising a first end, a second end, and a plurality of posts between said first end and said second end in a staggered arrangement comprising a number of rows between 12 and 15, said first tapered channel decreasing in width at an angle of 26.6°, said angle being defined at said first end with respect to a constant-width channel, said first end having a width between 0.5 and 5 μm, said posts having a cross sectional area equal to 1.5 μm^2 and separated by a gap equal to 0.5 μm.

27. The apparatus according to claim 26 comprising a second tapered channel, said second tapered channel connected to said first tapered channel at said second end and decreasing in width such that said DNA molecule, when present, is stretched, said second tapered channel having a length between 1 and 3 mm.

28. The apparatus according to claim 27 wherein said second tapered channel has a width that follows an equation of the form $W = (SHx/Q + C)^{-1}$, wherein x is distance from said second end of said first channel, H is height, W is width, S is strain rate, Q is an overall fluid flow, and C is a constant.

29. An apparatus for stretching at least one polymer in a fluid sample, said apparatus comprising an elongation structure, wherein said elongation structure comprises a channel with at least one bend, and wherein said at least one polymer, when present, moves along said channel and is stretched.

30. The apparatus according to claim 29 wherein said channel has a sinusoidal shape.

31. The apparatus according to claim 30 wherein said sinusoidal shape has a ratio of amplitude to period between 0.01 and 5.

32. The apparatus according to claim 29 wherein said channel comprises a plurality of straight sections joined in tandem at nonzero angles.

33. The apparatus according to claim 32 wherein each of said plurality of straight sections has the same length and said nonzero angles are equal in magnitude and alternating in sign, whereby said channel has a zig-zag shape.

34. The apparatus according to claim 33 wherein each of said nonzero angles has a magnitude between 5° and 75°.

35. The apparatus according to claim 1 wherein said channel comprises a plurality of obstacles to motion of said at least one polymer.

36. The apparatus according to claim 35 wherein said plurality of obstacles comprises a plurality of posts, at least one of said posts having a non-quadrilateral polygonal cross sectional shape.

37. The apparatus according to claim 36 wherein at least one of said plurality of posts comprises a concave edge.

38. An apparatus for stretching at least one polymer in a fluid sample, said apparatus comprising an elongation structure, wherein said elongation structure comprises a channel along which said at least one polymer, when present, moves in a flow direction, and wherein said channel comprises a plurality of obstacles to motion of said at least one polymer, said plurality of obstacles having cross-sectional area gradated down along said flow direction.

39. The apparatus according to claim 38 wherein said plurality of obstacles comprises a plurality of posts, at least one of said posts having a non-quadrilateral polygonal cross sectional shape.

40. The apparatus according to claim 39 wherein at least one of said plurality of posts comprises a concave edge.

41. A method for stretching at least one polymer comprising the step of:

moving said at least one polymer along the channel of the apparatus of any one of claims 1-40;

whereby said at least one polymer is stretched in said channel as said at least one polymer moves along said channel from said first end to said second end.